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Published in:
Book of Abstracts. DTU's Sustain Conference 2015

Publication date:
2015

Document Version
Publisher's PDF, also known as Version of record

[Link back to DTU Orbit](#)

Citation (APA):
Plakhotnyuk, M., & Hansen, O. (2015). TiO₂-Si solar cells with carrier selective contacts and low temperature processing. In *Book of Abstracts. DTU's Sustain Conference 2015* [E-37] Technical University of Denmark.

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TiO₂-Si solar cells with carrier selective contacts and low temperature processing

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Introduction. Most crystalline silicon based photovoltaic technology based on high temperature diffusion processes in the range of 800-900 °C. We present recent progress on development of low process temperature TiO₂-Si heterojunction solar cell with carrier selective layers with efficiency 2.39%, V_{oc} = 0.41V and J_{sc} = 9.79 mA/cm².

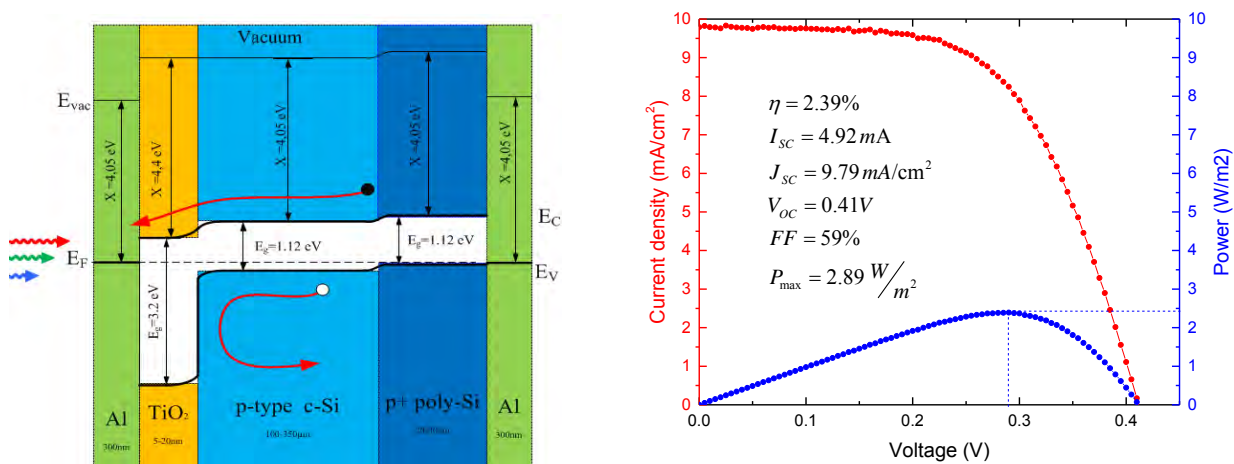


Figure 1: Energy band diagram of TiO₂-Si-poly Si structure (left), current-voltage and power –voltage characteristics (right)

Experimental results. Titania-silicon heterojunction solar cell was fabricated using ALD deposition of TiO₂ at 120°C. with the thickness of 20 nm on front side of silicon p-type wafer, polycrystalline silicon film was deposited on a back side of the silicon wafer. Titania is an electron selective layer as it was shown on the figure 1 (left). Polycrystalline boron doped silicon layer with the thickness of 25 nm play a role of a hole selective layer. 300 nm of aluminium was deposited on the backside of the cell and 15 nm on the front side of the cell. After fabrication the cell was characterized with a Newport solar simulator that allowed to measure current-voltage and power-voltage characteristics. The best solar cell device has shown 2.39% efficiency, open circuit voltage equal to 0.41 V, current density – 9.79 mA/cm², fill factor – 59% and maximum power 2.89 W/m². Our analysis has shown that current efficiency record was limited by 50% reflectivity from top aluminum layer, chemical surface damage of titania that caused inhomogeneity of the layer and due to other test process faults.

Further work focuses on optimization of ALD TiO₂ deposition parameters, titania protection during further processing, application low reflective top layers and contact that can improve solar cell efficiency and parameters.

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